DOCUMENT RESUME

ED 094 621 HE 005 736

AUTHOR	MacBride, Owen
TITLE	How Much Does Medical Education Cost? A Review. Health Manpower Policy Discussion Paper Series No. A3.
INSTITUTION	Michigan Univ., Ann Arbor. School of Public Health.
SPONS AGENCY	Robert Wood Johnson Foundation, New Brunswick, N.J.
REPORT NO	Ser-A3
PUB DATE	Aug 73
NOTE	55p.
EDRS PRICE	MF-$0.75 HC-$3.15 PLUS POSTAGE
DESCRIPTORS	*Cost Effectiveness; *Costs; Educational Finance; *Higher Education; *Medical Education; *Medical Schools; Student Costs; Surveys

ABSTRACT

This survey of studies of medical school costs was made in order to evaluate and compare the methodologies and findings of those studies. The survey covered studies of one or more medical schools that either produced figures for average annual per-student cost of education and/or discussed the methodologies and problems involved in producing such figures. Many problems can prevent the accurate estimation of per-student costs of education in medical schools. This is especially true if one is attempting to estimate an average cost or construct a "cost curve" using data from many schools; or if one is attempting inter-school comparisons. Studies of medical school costs have utilized three general methodologies. These have been labeled "net amount contributed," "costing," and "input-output analysis." No one of these appears to be clearly (empirically) more accurate than the others. However, the input/output method would appear to be the most accurate. The empirical results of these studies show no consistent pattern of costs of education over time. One might expect that these cost estimates, when adjusted for inflation, would show some rising trend due to increasing quality in the medical education process. (Author/PG)

Health Manpower Policy Discussion Paper Series

HOW MUCH DOES MEDICAL EDUCATION COST ?
A REVIEW

by Owen MacBride

Number: A3

August 1973

hmpp

Work on these papers is supported in total or in part by the Robert Wood Johnson Foundation

I. Purpose

II. Problems in Estimating Medical School Cost Functions

A. School Objectives
B. Multiple Outputs and Cost Allocations Among Programs
C. Resource Transfers Among Programs
D. Proper Valuation of Resources Used
E. Data Problems

III. Methodologies

A. "Net Amount Contributed" Method
B. "Costing"
C. Input-Output Analysis
D. "Constructed Costs" Approach
E. "Joint Costs"

IV. Empirical Results

A. Early Studies
B. Studies by Carroll
C. "Seven Centers" Study (Campbell)
D. Wing and Blumberg Study
E. Latham Study
F. Fein and Weber Study
G. Comparison of Empirical Results

V. Summary

A REVIEW OF STUDIES OF THE COST OF MEDICAL EDUCATION

I. PURPOSE

A survey of studies of medical school costs was made in order to evaluate and compare the methodologies and findings of those studies. The survey covered studies of one or more medical schools which either produced figures for average annual per-student cost of education and/or discussed the methodologies and problems involved in producing such figures.

II. PROBLEMS IN ESTIMATING MEDICAL SCHOOL COST FUNCTIONS

There are many problems which make it difficult to estimate a medical school cost curve. These can be grouped into the following categories:

A. School Objectives

Different medical schools may have different "aims" or "goals" thus they may be attempting to "maximize" different things, and produce different output mixes, in carrying out their operations. This was first noted by Henricksen and Davison, who gave it as one reason why it is futile to try to construct an "average" cost function for several schools.[1] This may be especially true with respect to a small-school (more education-oriented) versus larger school (more research-oriented) distinction. Wing and Blumberg attempted to overcome this problem by grouping their observations by amount of research expenditures.[11] Obviously, this can only be done where there is a large sample, as Wing and Blumberg had (82 schools).

Fein and Weber observed that medical schools are not profit-maximizers.[12] Since educators are highly concerned with "quality", schools also may not attempt to minimize costs. This observation leads to the conclusion that different schools use highly different production functions, thereby making it difficult to estimate one cost curve for all schools (Fein and Weber did not attempt to estimate such a curve).

With respect to the other major studies, Latham's dealt only with one school.[13] Campbell's dealt with seven schools; however, these were all large medical centers.[10] Therefore it is likely that they had similar objectives, hence output mixes and production functions.

B. Multiple Outputs and Cost Allocations Among Programs

Medical schools, especially large medical centers, produce a variety of outputs. In addition to M.D.'s, residents, interns, graduate science students, and auxiliary personnel are also trained. Aside from manpower, schools produce research, patient care, and other services. Thus to accurately estimate the cost of education of (for example) an M.D. degree candidate, one must identify the costs of that particular program.

Unfortunately, one "cost" or "expenditure" may benefit several programs. A prime example is a faculty member's salary; he may teach several different types of students, do research, and provide patient care in the teaching hospital. Procedures must therefore be developed for accurately allocating such "joint costs" among the various programs served.

Once such a system of allocating costs is devised, however, inter-school differences cause additional problems, or may result in the findings being misleading. For example, as suggested by Fein and Weber, there may be differences in quality among the faculties of various schools; therefore, there may be differences in expenditures (in input prices for faculty) among schools, which do not truly reflect differences in real costs.[12] Or, as Henricksen and Davison noted, different types of teaching hospitals may be affiliated with medical schools.[1] Various hospitals may place more or less emphasis on patient care rather than instruction, may be of varying quality, or may be subsidized to greater or lesser extents by other units of the school.

In section III below, the methodologies which the various studies utilized to overcome these allocation problems will be discussed in detail.

C. Resource Transfers Among Programs

A "sub-problem" of the multiple outputs problem is that of unmeasured resource transfers among the various medical school programs. These resource transfers fall in two general areas; first, expenditures made (in an accounting sense) on one program may also benefit other programs, thus the first program will be subsidizing the others. Second, outputs from one program may be inputs into another program. For example, the "patient care" output may be an input into the education of interns. Obviously, if costs of education are to be properly measured, at least part of the cost of producing the intermediate output must be charged to the educational programs into which it is an input.

To a large extent, this problem may be overcome by accurate allocation of joint costs among programs benefited as discussed above. Thus Carroll developed a detailed methodology for collecting and analyzing medical school data, to insure that each program is charged with its proper costs.[6,7] (These methodologies were utilized by Campbell[10], and the data used by Wing and Blumberg was collected by the Association of American Medical Colleges using Carroll's procedures.[11] It is also being used in general form by The National Academy of Sciences.[14])

It is also true that some studies assigned costs to undergraduate medical education which should not have been so allocated. This apparently occurred in most of the earlier studies[2,3,4,5], and to a lesser extent in the Henricksen and Davison study.[1] Costs which have been incorrectly charged to M.D. education include indirect research costs, costs of providing professional services to indigent patients, and costs of instruction of non-M.D. students. The later studies used more complex procedures to attempt to eliminate this problem.

However, most of the more recent studies apparently do not fully account for the outputs of one program which may be inputs into other programs. Only Latham explicitly considered this flow of outputs between programs.[13] This was done, using input-output analysis, by carefully charting the resource flows in the hospital Latham studied.

D. Proper Valuation of Resources Used

All resources used in production of program outputs must be properly valued. For example, Campbell's study can be criticized because it failed to include values for the contributions of voluntary faculty members and

of residents and interns in program cost estimates.[10] The National Academy of Sciences acknowledged that its cost estimates will be inaccurate to the extent that inter-program charges do not accurately measure the value of resource transfers between programs.[14]

Most studies have failed to assign a cost to the services of voluntary faculty members (National Academy of Sciences will be one exception[14]). The National Academy of Sciences in a pilot study of four schools found volunteer faculty ranged between 1.8 and 51.3 percent of full-time equivalent faculty. Failure to properly value these services can therefore lead to serious inaccuracies in the cost curve. For program costs to be accurately estimated, the services of each non-salaried faculty member must be assigned a value and that value must then be properly allocated among programs, as with the salaries of regular faculty members.

E. Data Problems

Lack of accurate, comparable data from all (or from a large number of) medical schools may also make it impossible to estimate an average cost function for all schools. Henricksen and Davison felt it futile to attempt to evaluate the budgets of two or more medical schools which did not have uniform accounting systems.[1] In order to accurately measure the costs of education, it may be necessary to develop a complex methodology, very different from that used by any medical school. This may require personal administration of the study by its directors at the participating schools, thus making it infeasible to include all (or a large number of) schools in the sample. To date, the studies which utilized the

most complex methodologies (Latham and National Academy of Sciences) have only studied a limited number of schools (one in the former study, fourteen in the latter)[13,14]. The study which used the largest sample (Wing and Blumberg, 82 schools) used data obtained from the Association of American Medical Colleges (AAMC)[11].

The leading studies used data as follows. Henricksen and Davison used financial records for 1934-1951 from Duke University School of Medicine and Hospital.[1] Carroll's various studies utilized data collected using methodology which he himself developed.[6-9] Campbell used data he obtained from seven medical centers.* Campbell collected his data using the basic methodology developed by Carroll.[10] Wing and Blumberg used data collected by the Association of American Medical Colleges for fiscal 1964-65. The data was collected in the Association's annual survey using Carroll's procedures. It covered 82 schools.[11] Fein and Weber also used data from the AAMC survey, for 1959-60 and 1965-66. Faculty salary information was obtained from the Medical School Salary Study 1967-68, published by the AAMC (1967). A few slight adjustments were made in the data before analyses were performed.[12] Latham obtained his data from an in-depth study of financial records for the University of Iowa Health Services Center. Fiscal years 1967-68 and 1968-69 were used.[13] Finally, the National Academy of Sciences is gathering data through a detailed study of 15

---

*Bowman Gray Center of Medicine and North Carolina Baptist Hospital; University of Iowa Health Sciences Center; Jefferson Medical College and Medical Center; University of Michigan Medical Center; New York University Medical Center; University of Utah Medical Center; Ohio State University Medical Center. Fiscal year 1967-68.

medical schools. This includes 10 which are medical/health science center based, and 5 which are university or hospital-based. The National Academy of Sciences will also conduct some limited analyses on data for all medical schools which will, again, come from AAMC's annual survey.

It therefore appears that the only data routinely (i.e. annually) collected on medical school finances is collected by the AAMC. This utilizes the procedures developed by Carroll.* Any data collection using a different approach would therefore have to come from a separate original effort.

III. Methodologies

In estimating "average cost per student", the main objective is to accurately measure the costs of education in each school, of that type of student. The various studies used several different methodologies to do this; however, these methodologies fall into three general categories.

A. "Net Amount Contributed" Method

This method involves subtracting, from total expenditures of the school, all revenues from programs not directly associated with education. Such revenues include clinic or hospital collections from patients, sponsored research grants, and so forth. The "net amount" figure thus obtained is then allocated to the various educational programs.

---

*Carroll wrote a manual describing tested programs cost-finding procedure to enable a medical college to determine the costs of its various education, service, and research programs; its income in relation to each; and its net investment in each. Carroll, A. J. A Program Cost Finding System for Medical Colleges - Manual of Procedures. Workbook prepared for the Third Institute on Administration - Association of American Medical Colleges, Evanston, 1965. Apparently it was intended that schools would use the Manual procedures in replying to the annual questionnaires. However, Carroll in one of his smaller studies noted that it was not clear this was being done.[9]

This method was used by Henricksen and Davison and is being used by the National Academy of Sciences. Henricksen and Davison felt this methodology would prevent such items as research costs, hospital charity costs, professional services to indigents, and costs of educating auxiliary personnel from being charged to undergraduate education. Their calculation was

> Net amount contributed by University = (annual expenditures of medical school and teaching hospital) - (receipts from outside teaching and research grants + collections from patients + gifts from foundations, etc.)

Note that tuition paid by medical students was <u>not</u> subtracted. The "per student" figure was then obtained by dividing "net amount" by "number of medical students". Henricksen and Davison noted that this measure still included some improper items under "cost of education": some services to the public, some research expenses, and some expenses of instruction to non-medical students.[1]

The National Academy of Sciences version of this method "defines total education costs as the gross cash expenditures of the health professional school, less revenues earned from patient care and sponsored research, and prorates education costs based on student enrollment". Their approach depends on several assumptions, of which the following two may be questionable: (1) in the course of educating students, schools generate revenues through secondary programs, and these revenues are in the long run equal to the costs of operating the secondary program; (2) any secondary program activity to which the school commits faculty and other resources for which it receives no revenue must be essential to the "educational environment".

The National Academy of Sciences methodology has the following advantages: it utilizes existing available data on expenditures; it avoids judgmental allocation; and it considers the financial needs of the entire school. On the other hand, it has the following disadvantages: inter-school comparisons may be weakened because offsetting income and non-cash costs vary across schools (access to educational resources, including Federal funds varies widely between schools); the accuracy of year-to-year comparisons is dependent on stable funding of research and patient care; and distortions may result because non-cash costs are omitted.

(National Academy of Sciences has yet to determine the process to be used to allocate the "net expenditures" among the various education programs.[14])

In general, the "net amount contributed" methodology has several shortcomings. First, revenues from the "non-educational" programs may not actually match the costs of those programs hence a subsidy of (for example) "instruction" by "research" will not be accurately measured.* Second,

---

*Wing studied the clinical costs of intern and resident education (the portion of hospital costs attributable to intern/resident programs). Using regression coefficients derived by Carr and Feldstein,[17] he estimated an annual cost to the hospital of $8300 per house officer, of which $5250 was capital costs (1963 data). This figure did not include stipends paid by the hospital to interns and residents for their services (estimated at $4037 per house officer). Wing concluded that the costs incurred by hospitals are substantially larger than those incurred by the medical schools.[16]

Wing's study did not consider the amount of revenues from patient care generated by the services of interns and residents. Since hospital teaching costs may not be explicitly dealt with in some studies, it is important to understand the implications when these revenues do not match the "non-teaching" costs of providing patient care. To the extent that patient care revenues exceed "non-teaching" costs, the "net amount contributed" approach will understate the cost of education of interns and residents. To the extent that patient care revenues are less than these "non-teaching" costs, the "net amount contributed" approach will overstate the cost of education; that is, it will charge part of the cost of patient care services to the resident/intern education program.

this methodology does not consider that some of the "non-educational" programs, such as patient care provided by the teaching hospital, may actually be an essential input to M.D. education, therefore part of their costs should be charged to the educational programs. Third, there may be non-cash or undervalued inputs (e.g. voluntary faculty) which are not properly valued as resources since they are not included in "total expenditures" of the school. Finally, judgmental allocations may be necessary in distributing the "net amount contributed" among the various educational programs.

B. "Costing"

This method involves carefully defining medical school programs ("functions", "outputs", etc.) and explicitly identifying the expenses and activities which enter into the "production" of each medical school program. Each activity/expense is then allocated to the program to which it is an input. Those activities/expenses which go to the production of more than one program must be allocated among the various programs. The sum of the allocations to each program is the "cost of that program This methodology was originally developed by Carroll, and has been continued and expanded in the Campbell, Wing and Blumberg, and National Academy of Sciences studies.

The accuracy of the "costing" method obviously depends on the accuracy with which (a) programs, activities, and expenses are defined; (b) allocations are made; and (c) non-cash and under-valued inputs are correctly valued. To the extent that these are accurate, some of the problems of the "net amount contributed" method can be lessened.

Carroll presented a detailed analysis of "fundamental medical college functions", the "activities and expenses related to fundamental medical

college functions," and exclusions from medical colleges costs (costs relating to "secondary medical college functions"). Carroll noted, "In deciding on the activities and expenses which, for this report, are included in 'medical college costs', we have been guided by the most common practices in the colleges visited, not by our own opinions...Our methods of presenting cost comparisons are not so simple and direct as they would be if it were not necessary to obscure the identities of the various schools."[6]

Carroll also presented a chart illustrating procedure for converting "medical college expenditures" - the type of aggregate expense figure which would be available from a medical school - to "Medical College Costs", a more accurate measure of the costs of undergraduate medical education. These calculations (for state schools; the form is slightly different for private schools) are as follows

Total Expenditures

Minus expenses not related to fundamental medical college functions (Subsidy-hospitals and clinics; salaries of residents; social services expenses; post graduate education expense; public health education expense; other educational programs; student aid and scholarships; special medical services; teaching and research beds)

Plus expenses related to fundamental medical college functions but not paid by the college (Teaching expenses paid by hospitals, clinics, institutes, gifts, and grants; Paid from medical service funds; teaching services provided by other units of the University, endowed professorships; other services provided by the University: administration, buildings and grants, student health, library)

Equals Total Costs

Note that this calculation scheme could also be viewed as a complex "Net amount contributed" approach.

Campbell expanded upon the above methodology in his study of seven major medical centers. He paid special attention to the problem

of proper allocation of faculty salary. As was mentioned above, a faculty member may be involved in several programs (teaching of various types of students, research, patient care, etc.) Thus a proper means of allocating his salary cost to these various programs must be employed. Campbell used "effort reporting". Each faculty member in the participating schools, under detailed instructions, recorded the percentage of his daily effort which went to each program of the school. These estimates were then used to allocate salary costs to the various programs.[10]

Campbell's methodology can be criticized on several grounds. First, it considered all research and patient services as stricly final consumption outputs, and did not attempt to measure the contributions of these programs to each other and to educational programs. Second, the contributions of residents and interns were not included in determining cost estimates. Third, the contributions of voluntary faculty members were also excluded as were hospital subsidies and capital costs. For these reasons, Campbell's average cost figures may be understatements. Also, Campbell apparently did not use a uniform methodology for all seven centers; there were some variations made at each center to deal with the particular characteristics of that center.

Wing and Blumberg utilized AAMC data collected using the Carroll methodology. However, they manipulated the data in several ways in an attempt to overcome some of the problems discussed above.

First, Wing and Blumberg separated the 82 schools in their sample into four groups, to overcome data problems caused by wide variations in schools sizes and outputs. The grouping was done by public versus private schools and by amount for sponsored research dollars (above and below $2,350,000).

Second, a cost variable, "non-sponsored expenditures", was defined as follows:

Non-sponsored expenditures = Total expenditures - (Sponsored research expenditures) - 1/2 x (teaching and training grants and contracts) - (overhead share for sponsored research and teaching and training)

Where "overhead share" = $\frac{\text{(sponsored research + 1/2 (teaching \& training)overhead}}{\text{sponsored research + (teaching \& training)}}$

(Assumption: all sponsored research funds are actually spent on sponsored research).

Third, a model of the medical school was defined, which included four educational programs. These were undergraduate medical education, clinical post-M.D. education (residents and interns), graduate academic education, and (at large schools only) clinical science degrees, a proxy for clinical science students. "Sponsored research expenditures" was used to measure the size of the school's research program.

Finally, several types of regression analyses were attempted, to ascertain per-student costs in each of the educational programs. The interpretation of the regression results is summarized and discussed in section IV below.[11]

The Wing and Blumberg study has the following limitations: First, no data was used on the contribution of voluntary faculty. Second, patient care, hospital and clinical services, and community service programs were omitted from the model, in the absence of a suitable measure of output for them. One would expect these omissions to cause an upward bias in the coefficients of the included variables, hence an upward bias in the estimates of cost of education per student. Third, funds from certain income sources (which varied from $0 to $3.5 million across the medical schools) were included in total resources available, although the authors agreed that these income sources in many cases do not reflect the resource use of primary inputs. Latham[13] states that, because of these shortcomings, the Wing and Blumberg

study seriously underestimates the cost of undergraduate medical education while grossly overestimating the cost of graduate education programs. Finally, the assumption that all sponsored research funds are actually spent on sponsored research is probably incorrect. It is likely that these research funds subsidize to some extent educational programs.

The National Academy of Sciences' "costing approach" involved identifying all resources used by the school in its operation and allocating an appropriate share of the value of each resource to each program. This is a four-step process. First, the principal output programs must be identified. Second, all resources used must be identified, and the costs associated with each resource. Third, the personnel, facilities, equipment, and overhead of each school which contribute only to one program must be identified and their costs allocated entirely to that program. Finally, for the above items which contribute to more than one program proper methods for allocating these costs among the various programs must be developed, and the allocation made.[14]

According to the National Academy of Sciences, this approach has the following advantages: (1) it provides a theoretical resource base for funding; (2) it facilitates inter-school and year-to-year comparisons of consistent data; and (3) it requires the same basic data (plus some other information) as the "net expenditures" approach. However, "costing" has the following disadvantages: (1) it requires substantial judgemental allocations; (2) the data-gathering process may be expensive and time-consuming.

The most difficult problems (thus most likely sources of error) in carrying out the "costing" methodology will apparently come in the following areas: identifying and allocating support costs which benefit more than one school of the university (e.g., the general library); imputing proper costs to non-cash or undervalued services (such as volunteer faculty effort or

depreciation costs); and allocating faculty salary by program. In this latter area, National Academy of Sciences has concluded that the "effort reporting" system used by Campbell introduces "more subjectivity and opportunity for bias than is acceptable." Instead, this study will utilize "activity reporting", which will require faculty members to specify actual hours or percentage of time spent in clearly defined activities. Explicitly defined allocation criteria will then be used to allocate the time spent on each activity to the various output programs. The National Academy of Sciences plans to survey ninety percent of full-time faculty, fifty percent of part-time faculty, and twenty percent of volunteers, at the sample 15 medical schools.

In general, the "costing" method may also fail to properly identify "intermediate" outputs of some programs as input costs into other programs. This may be either an undervaluation (intermediate outputs not charged as input costs to educational programs) or an overvaluation (entire cost of producing intermediate outputs charged directly to educational programs).

C. Input-Output Analysis

The third general methodology is input-output analysis. It is similar to the "costing" approach. That is, the medical school's primary inputs, and output "activities", must be identified, defined, and costed. However, by carefully defining and tracing "resource flows" through the medical school, this method attempts to accurately measure (a) inter-departmental resource transfers, and (b) outputs from some programs which become inputs into other programs.

This method was used exclusively by Latham among the studies surveyed. He employed a "theory of the Firm" analysis of the medical college, emphasizing the interrelated activities of production and the multiple outputs. Primary

inputs were identified as follows professional services (the faculty of each of the 24 departments of the medical school studied); teaching and research associates; teaching and research assistants; residents by year of residency; interns; administrative personnel; other professionals; technical service personnel; clerical personnel; general service personnel; direct supplies services; equipment services; and building services. Then, production activities were defined: general administration; undergraduate medical courses (30 different ones); medical education by year; medical degrees; "other" education (interns, post-Ph.D., auxiliary education, etc.); research; special services and programs (e.g., Regional Medical Program); and patient services.

Through careful study of the medical school, the "resource flows" of inputs and among programs and activities were identified (see Table 1, "Conceptual Resource Flow Table for the College of Medicine", outlining these resource flows). Input/output analysis was next used to derive input coefficients, which were then used to determine the total, average, and marginal costs of the activities of the medical college.[13]

With respect to using input/output analysis to estimate a cost curve for all medical schools, the main shortcoming of this method would seem to be its complexity. This complexity would make it very difficult (costly) to use this approval in a study of all medical schools (Latham himself only applied the method to one school, The University of Iowa Health Sciences Center). Further, the system of "resource flows" at different schools may vary widely. This adds to the complexity of the method, means each school probably must be studied in great detail, and mitigates against development of "uniform methodology" which can be easily applied to all schools.

TABLE 1: Conceptual Resource Flow Table for the College of Medicine (Latham Study)

Production Activities

	Inputs to Productive Activities	Gen. Admin.	Med. Courses	Med. Ed. Year	MD Degrees	Other Educ.	Research	Other Programs	Patient Serv.		Total Output		Final Consumption Output	Educational-Inventory Output	
3	Gen. Admin.		X	X		X	X	X	X		X				
2	Med. Courses			X		X					X		X		
2	Med. Ed. Year				X						X		X	X	
1	MD Degrees										X		X		
2	Other Educ.			X							X		X		
2	Research		X	X		X			X		X		X		
2	Other Programs	X	X	X		X	X	X	X		X		X		
2	Patient Serv.		X	X		X	X	X			X		X		
4	Prof. Serv.	X	X	X		X	X	X	X		X				
4	Admin. Person.	X	X	X		X	X	X	X		X				
4	Resid. & Int.		X	X		X	X	X	X		X				
4	Other Person.	X	X	X		X	X	X	X		X				
4	Non-Human	X	X	X		X	X	X	X		X				
5	Educational Inv.				X						X				

1: Implies strictly final output

2: Implies mixed final and intermediate output

3: Implies strictly intermediate output

4: Implies primary input

5: Implies educational-inventory input

Source: Latham, Robert J. The Cost of Medical Education: An Empirical Analysis of Production, Doctoral Dissertation, Department of Economics, University of Iowa, Iowa City, Iowa, 1971.

D. "Constructed Costs" Approach

The National Academy of Sciences is introducing a new, fourth methodology which is somewhat non-empirical. This "constructed costs" method will involve asking medical school "experts" what the educational costs would be in "model" medical schools. These "planners" will be asked to estimate resource requirements necessary to operate the "ideal" school, then determine the additional resources necessary to make the cost figures representative of a "real world" school costs. National Academy of Sciences hopes that such differences will provide insights into the causes of variability in costs among different schools; and will help define "an adequate level of resources for an M.D. and D.D.S. education program in an acceptable educational environment." Thus, while this procedure may not be useful for determining actual costs of education, it may be extremely valuable to the National Academy of Sciences in carrying out its assigned function of determining how to set capitation grants.

E. "Joint Costs"

The methodologies of Carroll, Campbell, and Latham have been criticized by Koehler and Slighton of the Rand Corporation.[18] According to Koehler and Slighton, the "flaw" in these methodologies lies in the common "goal" which they all share, a goal which derives from classical cost accounting. This goal is that of finding a method of allocating total institutional costs across the medical school's set of final products in such a way that the sum of product costs equals total costs.

The Carroll, Campbell, and Latham approaches all attempt (using varying allocation systems) to allocate the total costs of the medical school to its various programs (education, research, etc.). But Koehler and Slighton contend that it is impossible to make an unambiguous allocation of institutional costs to the final products so that the sum of the costs

assigned is equal to the total institutional costs. That is, it is not sound to divide the medical school into several unique "programs" or "cost centers" and then distribute all or part of each cost item to one of the "cost centers". This is because there are significant "joint costs" in the medical school, costs which arise from the fact that program _A_ must be conducted in order for program _B_ to be conducted, and which cannot be assigned solely to one or the other programs.

More specifically, Koehler and Slighton define the cost of joint production involving a particular product as

> ...The difference between (a) the estimated cost of the activity under the assumption that it has been modified to result in the least possible output of the remaining products compatible with maintaining the initial output of the product in question and (b) the part of the cost of the activity that is strictly assignable to that product.

"Program costing" is valid, according to the authors, only if costs are assigned to individual products only when they arise solely from the product, and otherwise to "joint products". Attempts to assign these "joint product" costs to individual products introduces much ambiguity and arbitrariness into the accounting process, resulting in inaccurate cost figures. An example of how arbitrariness may enter the "costing" system is in the "faculty effort" or "activity" report.

Koehler and Slighton view input-output analysis as just a modification of program costing. Input-output analysis was developed to measure the many transactional flows among industries in the economy, and is therefore not very useful in the medical school context because there is not a very large flow of transactions among the various medical center activities. (Latham's own matrix of resource flows, the authors claim, illustrates this: only about five percent of the cells have non-zero entries indicating resource flows between activities). Further, Koehler

and Slighton say, input-output analysis assumes (a) there are no joint costs (b) all products are independently produced. Koehler and Slighton feel these are invalid assumptions.

The regression analysis method used by Wing and Blumberg is also criticized by Koehler and Slighton. As Wing and Blumberg themselves point out, the accuracy of their method depends on several strong assumptions: (1) all schools have the same program costs; (2) there are not joint costs among programs; (3) there are constant returns to scale in each production process. In particular, Koehler and Slighton feel assumption (2) to be invalid. And, to the extent that jointness is important, Wing and Blumberg's linear model, which cannot measure jointness, will produce biased coefficients. Also, Koehler and Slighton point to the fact that Wing and Blumberg's "subsample" equations are quite different from their "all school" equation (See Tables 6 and 8) as evidence that assumption (1) is incorrect.

Koehler and Slighton summarize the correct cost assignment procedure under circumstances of joint costs as follows:

> There are two stages to this procedure. The first, aimed at capturing those elements of joint cost that derive from the technology of producing medical school outputs, consists of allocating activity costs by means of observations, interviews, or effort reports to two sorts of cost centers - "pure" processes (or outputs) and "technologically joint" [processes] (or outputs). The number of cost centers given over to pure processes will be matched by an equal number of cost centers concerned with technologically joint processes. The sum of the costs allocated to pure cost centers, will be less than the total costs of the activities examined. The sum of the cost allocated to all cost centers, pure and technologically joint, will be greater than the total activity cost.
>
> The second stage of this cost assignment procedure aims at capturing those elements of joint costs deriving from considerations of joint supply. It consists of estimation (by some unspecified procedure) of the extent to which the sum of the pure and technologically joint costs of a particular product is less than the cost of those inputs that must actually be purchased in order to secure that product. The sum of this difference and the technologically joint costs is the total joint cost involving that product.

> The end result of this two-stage procedure is thus two sets of cost estimates - a set of pure or strictly allocable costs and a set of estimates of pure plus joint costs. The pure cost of a product is its cost of production under the assumption that the outputs of the other products of the system are maintained at existing levels. The sum of the pure and joint costs of a product is the cost of producing that product and such other products as must be produced jointly with it under the assumption that these other products are produced in minimum feasible amounts.

Koehler and Slighton say that their "joint cost" method will not answer the questions "What is the unique 'true' cost of program X?" or "What is the 'true' cost of producing one unit of output from program X?" However, the authors do not feel that these are relevant questions for medical school policymakers, anyway. Koehler and Slighton are apparently more concerned with the questions, "What is the total cost resulting from program X?", and "Will a new program, X, pay for itself?", rather than the issues of per-student costs of education.

IV. EMPIRICAL RESULTS

A. Early Studies

Several studies of costs of education for the M.D. degree were made during the 1940's and early 1950's.[1-4,15] These are summarized in Table 2. Note that four of these studies were made in the 1949-1951 period. However, the estimates of annual per-student costs for these four studies vary widely.

The Weiskotten, Council on Medical Education and Hospitals, Federal Security Agency, and National Fund for Medical Education studies were described as incorrect by Deitrick and Berson because these studies charged the indirect research costs, costs of providing professional services to indigent patients, and costs of instruction of nonmedical students, to undergraduate medical education. Dietrick and Berson felt a more accurate measure would involve separating total medical school costs into hospital expenses, education costs, research, and service.[5]

TABLE 2: Some Early Estimates of Annual Per-Student Costs (undergraduate medical education)

Year[1]	Source	Estimate
1934	Davison and Henricksen[6]	$1582
1940	Weiskotten[2]	$1052
1949	Council on Med. Ed. and Hosps.[3]	$917-$9500 (range)
1950	Ntl. Fund for Med. Ed.[4]	$3339
1951	Fed. Security Agency (P.H.S.)[5]	$754-$8257 (range)
1951	Henricksen and Davison[6]	$2192

[1]Year of Publication of Study

[2]Weiskotten, H. G., "Medical Education in the United States and Canada", American Medical Association, Chicago, 1940. Along with his estimate, Weiskotten noted that medical school funds are frequently utilized for support of other broad programs of social endeavor.

[3]Anderson, D. G., and Tipner, Anne, "Medical Education in the United States and Canada", Journal of the American Medical Association, Vol. 141, p. 43 (September 3, 1949).

[4]National Fund for Medical Education. "Medical Education in the United States", New York, 1950.

[5]Federal Security Agency, Public Health Service, "Report of the Surgeon General's Committee on Medical School Grants and Finances," Part II, Financial Status and Needs of Medical Schools, Washington, D.C., U.S. Government Printing Office, 1951.

[6]Henricksen, Gerhard C. and Davison, W.C., "Cost of Undergraduate Medical Instruction in an Endowed School", Journal of the American Medical Association, Vol. 199, p. 99, (May 10, 1952). (Dealt with Duke University School of Medicine and Hospital only.)

As discussed in section III above, Henricksen and Davison utilized a "net amount contributed" approach. Their figures, for Duke University, School of Medicine and Hospital, 1934-1951, are presented in Table 3, (Years 1931-33 were omitted from the table as unrepresentative due to high "start-up costs" of the medical school in those years). Note that there has been substantial variation in costs from year-to-year, both in the direction of change and in annual amount of change. For example, between 1942-43 and 1943-44, average costs dropped from $1951 to $1656. In the next year, however, costs increased back to $2098.[1]

B. Studies by Carroll

Carroll's efforts are regarded as the "landmark" work on medical college costs, because of the detailed methodology for measuring those costs which he developed.[6,7] Two major purposes behind Carroll's work were (1) to show that past attempts at measuring "per student costs" had been inaccurate, misleading, and overemphasized; and (2) to develop a uniform methodology of measuring costs by program so that per-student costs could be accurately determined, and validly compared between schools, in the future. With respect to the first purpose, Carroll[6] said,

> The popular assumption that total medical college costs are proportionate to the number of undergraduate medical students is unproven and fallacious. Nevertheless, the most used, the most impressive, and the most wanted medical college cost figure is cost per student. At the same time, these unit costs have been the most misused, misleading, and often the most startling and disturbing cost data. Despite the many demands for accurate and comparable medical college per student costs, most attempts to produce them have failed...The practice of computing per student costs by dividing total medical college costs by the number of medical students is improper and misleading.

With respect to the second purpose, and the methodology he developed in pursuit thereof, Carroll[6] stated;

TABLE 3: Annual Per-Student Costs of Education, M.D. Degree Students, at Duke University, 1934-1951

Year	Cost	Deflated Cost	
		By CPI[2]	By MCPI[3]
1933-34	$1582		
1934-35	$2071		
1935-36	$2173	$5287	$6019
1936-37	$1962		
1937-38	$2098		
1938-39	$2385		
1939-40	$2495		
1940-41	$2527	$6017	$6869
1941-42	$2304		
1942-43	$1951		
1943-44	$1656		
1944-45	$2098		
1945-46	$2717		
1946-47	$3074		
1947-48	$3626		
1948-49	$2439		
1949-50	$1789		
1950-51	$2192	$3040	$4082

[1]Source: Henricksen and Davison (see Note 6, Table 2).

[2]Deflated by Consumer Price Index, 1967 = 100. C.P.I. picked as representative of "lower bound" of inflationary trend in medical school costs.

[3]Deflated by Medical Care Price Index, 1967=100. M.C.P.I. picked as representative of "upper bound" of inflationary trend in medical school costs.

> With program costs it is necessary only to divide the cost of undergraduate medical education by the number of undergraduate medical students to find the cost of educating a student to become a doctor. Results obtained by other methods are inaccurate and misleading.

Most of Carroll's initial work was therefore devoted to illustrating how past inter-school cost comparisons had been misleading, and demonstrating how his program-costing method worked (utilizing budgeting data from one school, State University of New York at Syracuse). Data on faculty salaries and departmental budgets, for a small number of schools that were studied, and some aggregate (all schools) figures, were presented. Carroll did present one per-student cost figure. He said that a school with a faculty work pattern and per-student investments similar to that at SUNY-Syracuse would have a cost of education of $2300 per M.D. degree candidate (1965-56 data).[6]

Carroll also did some later, small-scale studies using his methodology. In one, he presented illustrative data on program costs and related income for a college of medicine, based on a study of 12 schools (1959-60 data). Table 4 shows the ranges of these figures for the 12 schools in the study. "Costs" were defined as all expenditures, made by the medical college from whatever source, for whatever purpose, plus expenditures others have made in its behalf. "Gross program costs" were the total cost of each program without regard to sponsorship or source of support; and "related income" was defined as the income received by the school because of or in the name of each program. No per-student cost figures were derived, and it was again stated that any attempt to do so using this data would result in seriously misleading figures.[9]

TABLE 4

Summary of the High and Low Gross Program Costs, Related Income, and Program Deficits as They Occurred in the Financial Data of 12 Medical Colleges for Fiscal Year 1959-60*

Line No	Medical College Programs	Column 1 Gross Program Costs		Column 2 Related Income		Column 3 Program Deficits Paid by College	
		High	Low	High	Low	High	Low
1.	Primary program						
2.	Undergraduate medical education (for M.D. degree)	$ 803,937	$345,344	$ 705,521	$230,712	$455,634	$ 90,179
3.	Supporting programs						
4.	Education						
5.	Graduate programs (for Master's and Ph.D. degree)	143,935	9,066	90,655	....	70,252	6,969
6.	Intern and resident	656,551	94,940	420,000	....	656,551	46,741
7.	Postdoctoral	283,138	1,945	283,138	....	32,082	12,800†
8.	Continuing medical education for practicing physicians	110,713	2,054	60,901	....	49,812	2,054
9.	Other educational programs	196,887	31,293	119,068	....	116,625	13,027
10.	Research (total costs)	3,512,199	343,160	2,879,694	223,410	632.505	62,423
11.	Services						
12.	Advisory services to granting agencies	40,867	1,658	17,500	....	40,483	....
13.	Hospital, clinic, etc. services	949,377	101,707	756,232	....	434,817	203,371†
14.	Community and public services	88,000	18,494	66,749	....	71,071	....
15.	Patient services	1,213,259	58,118	1,213,259	....	458,795	69,325†
16.	Other service programs	124,713	....	500	....	124,713	....

Line No		High	Low
17.	Ranges of student enrollments	High	Low
18.	Undergraduate medical students	445	206
19.	Graduate students	60	6
20.	Interns and residents	282	25

* The high and the low gross program costs, respectively, were $7,397,846 and $1,172,362; related income, $5,428,728 and $747,856; and program deficits paid by college, $1,968,918 and $84,011.

† Amounts are surpluses.

Source: Carroll, A.J., and Darley, Ward. "Medical College Costs", Journal of Medical Education, Vol. 42, p. 1 (Jan. 1967).

In another article, Carroll and his associates looked at the sources of expenditures made by medical colleges. Data was used from 26 private and 16 public medical schools, for years 1940-1941, 1947-1948, 1959-1960, and 1961-1962. The sources of funds for "basic operations" (as opposed to "research training" and "sponsored research") were examined. However, once again no "per-student" figures were presented.[8]

C. "Seven Centers" Study (Campbell)

Table 5 summarizes the empirical results obtained by Campbell in his detailed study of seven major medical centers. Campbell found that on the average, the seven centers devoted 6.1 percent of total costs to undergraduate medical education, at a cost of $3700 per year per M.D. degree candidate. The annual cost of education per student in M.A./Ph.D. programs was $1200, and for intern and resident education, $7000. Further, 22.3% of total program costs, on the average, went to research efforts, while 49.0 percent of total costs went to patient care.[10]

The fact that Campbell's sample size was only seven makes his "average" figures somewhat unreliable for purposes of generalization to all schools. The "range" figures presented in the summary table are possibly more useful for such purposes. Also, this study involved large, complex medical centers. One would thus expect that the figures derived would not be useful for generalization to smaller schools, because (a) larger schools should experience more scale economies, benefits of interactions between programs, etc. (b) larger schools may produce significantly different "output mixes" than smaller schools.

TABLE 5: A Summary of Empirical Results of the "Seven Centers" Study*

Program	Percent of Total Program Costs		Cost Per Student	
	Average	Range	Average	Range
Undergrad. Medical Educ.	6.1%	5.9-6.2%	$3700	$2800-$4300
Masters/Ph.D. Education	4.2%	2.8-6.1%	$7200	$3700-$11,700
Intern and Resident Educ.	5.0%	3.7-7.1%	$7000	$5300-$9100
Research	22.3%	17.3-26.5%	--	--
Patient Care	49.0%	42.1-55.7%	--	--

Source: Campbell, T. J., Program Costs Allocation in Seven Medical Centers: A Pilot Study. Association of American Medical Colleges, 1969.

*Data used was for F.Y. 1967-1968.

D. Wing and Blumberg Study

Wing and Blumberg attempted three sets of regressions on their grouped data (i.e., the regressions were done separately on each of the four groups) and also on all 82 schools together. In the first set of regressions, the dependent variable "non-sponsored expenditures" was regressed on variables representing program sizes. These independent variables were the numbers of students in, respectively, undergraduate M.D., graduate academic, and clinical post-M.D. programs. A fourth independent variable was the number of clinical science degrees, a proxy for number of clinical science students, on which data was unavailable. A fifth independent variable was sponsored research in dollars.

The results of these regressions are summarized in Table 6, showing the coefficients of the various program variables.* The interpretation of a coefficient x is that an additional student in a particular program (or an additional dollar of sponsored research) will cause an increase of x dollars in "nonsponsored expenditures". Thus, for all schools (zero-intercept model), Wing and Blumberg found the average annual per student cost of education to be $4016 for M.D. degree candidates, [illegible] for basic science students (graduate academic education), and $4182 for interns and residents.

*T-statistics (in parenthesis in Table 3) indicate the reliability of the regression coefficient. Generally speaking, coefficients should be regarded as more reliable the higher the T-statistics, and those coefficients in this table with T-statistics below 1.7 should be regarded as unreliable. R-squareds indicate the amount of interschool variation accounted for by the model-the closer to 1.00, the better.

The interpretation of a constant term x is that, even if none of the programs represented by the independent variables are conducted, the school will still have $x of non-sponsored expenditures. That is, the constant measures expenditures caused by factors/programs other than the included ones. A zero-intercept model assumes no non-sponsored expenditures when all programs are inoperative, i.e., all non-sponsored expenditures are made on these five programs.

TABLE 6: Empirical Results of Wing and Blumberg Study (1964-65 Data) - "Nonsponsored Expenditures" Regressions

Program	Class of School									
	Small Research Expenditures (1)				Large Research Expenditures (2)					
	Nonstate School (n=15)		State School (n=16)		Nonstate School (n=29)		State School (n=22)		All Schools (n=82)	
	C (3)	Z (4)	C	Z	C	Z	C	Z	C	Z
Medical Undergraduates	$22 (0.01)	$4,697 (2.47)	-$2,580 (-0.89)	-$754 (-0.26)	$8[illegible]8 (0.40)	$1,799 (1.47)	$4,888 (2.16)	$5,152 (2.90)	$3,723 (3.19)	$4,6[illegible]6 (5.41)
Basic Science Students	$1,674 (0.24)	-$2,538 (-0.37)	-$4,796 (-0.72)	-$5,763 (-0.81)	$3,153 (0.56)	$4,042 (0.75)	$6,670 (0.94)	$6,503 (0.95)	$6,992 (2.37)	16,978 (2.38)
Interns, Residents, and Clinical Fellows	$395 (-0.11)	-$1,011 (-0.26)	$13,596 (2.29)	$10,246 (1.73)	$4,878 (2.90)	$4,875 (2.94)	$5,395 (1.67)	$5,605 (1.89)	$4,143 (3.28)	$4,182 (3.35)
Clinical Science Degrees					$17,211 (1.72)	$15,997 (1.66)				
Sponsored Research	$0.305 (0.56)	$0.485 (0.85)	$0.329 (0.46)	$1.195 (2.41)	$0.223 (2.90)	$0.230 (3.09)	$0.099 (0.48)	$0.108 (0.55)	$0.179 (2.87)	$0.181 (2.94)
Constant	$1,617,315 (1.61)	0	$1,602,841 (1.62)	0	$507,349 (0.60)	0	$223,807 (0.20)	0	$143,403 (0.33)	0
R^2	0.09	-0.15 (5)	0.60	0.50	0.74	0.74	0.60	0.60	0.65	0.65
Mean Nonsponsored Expenditures	$2,094,556		$3,161,126		$4,387,068		$5,404,134		$4,001,369	
Standard Error of No Regression	$774,791	$828,911	$841,819	$897,384	$1,062,292	$1,047,943	$1,464,878	$1,425,253	$1,222,751	$1,215,728

Basic model is: Nonsponsored Expenditures vs. Undergraduates, Basic Science Students, Clinical Post-doctoral Students, Clinical Science Degrees, Sponsored Research.

The first entry is the regression coefficient; immediately below in parentheses is the corresponding t-statistic.

(1) Sponsored Research < $2,350,000

(2) Sponsored Research > $2,350,000

(3) C-model with constant

(4) Z-zero intercept model

(5) Negative R^2 means that a model with only a constant term (equal to mean of independent variables) would give smaller squared error.

Each sponsored research dollar spent by schools necessitated an additional 18 cents of non-sponsored expenditures. Finally, clinical science degrees, which (due to data limitations) were only included in the regressions on nonstate schools with large research expenditures cost $15,997 each to produce (zero-intercept model).

Wing and Blumberg also attempted a similar set of regressions which added "M.D. - degree candidates-squared" as an independent variable. This quadratic equation was intended to measure any scale economies, i.e. "minimum cost points", in the medical education process. The squared-term was included only for M.D. degree candidates because, as the authors stated

> We felt that significant opportunities for operating scale economies exist primarily in medical undergraduate programs which may have traditional lectures attended by the entire class....Medical undergraduate programs offer some real opportunities for scale economies primarily because they <u>can</u> use large class sections and lectures.

Unfortunately, the T-statistics for the coefficients of the squared terms were all very small. Thus Wing and Blumberg were unable to make any conclusions regarding the presence of operating scale economies in medical undergraduate education.

A final set of regressions attempted to relate sponsored research expenditures (dependent variable) to the size of the various educational programs. These regressions were similar to the first set, with the independent variables being the enrollment size.

Results are summarized in Table 7. The interpretation of the regression coefficient here is that it represents the amount of sponsored research dollars "attributable" to each student of a particular type. It indicates the participation of the various types of students in sponsored research. Although T-statistics for these coefficients were

TABLE 7: Empirical Results of Wing and Blumberg Study (1964-65 Data) "Sponsored Research" Regressions.

Educational Program	Class of School									
	Small Research Expenditures (1)				Large Research Expenditures (2)					
	Nonstate Schools (n=15)		State Schools (n=16)		Nonstate Schools (n=29)		State Schools (n=22)		All Schools (n=82)	
	C (3)	Z (4)	C	Z	C	Z	C	Z	C	Z
Medical Undergraduates	$571 (0.30)	$1,755 (2.13)	-$817 (-0.70)	$886 (0.56)	$217 (0.04)	$3,920 (1.23)	-$3,756 (-1.56)	-$2,473 (-1.24)	-$2,957 (-1.41)	-$1,472 (-1.0[illegible])
Basic Science Students	$3,502 (0.93)	$2,612 (0.75)	$3,514 (1.39)	$6,677 (1.90)	$16,811 (1.15)	$20,694 (1.50)	$20,694 (4.13)	$24,209 (4.19)	$16,074 (3.19)	$16,181 (3.[illegible])
Interns, Residents, and Clinical Fellows	$5,367 (4.31)	$5,453 (4.50)	$4,575 (2.26)	$5,508 (1.87)	$7,167 (1.70)	$7,369 (1.76)	$6,908 (2.11)	$8,422 (2.95)	$11,743 (6.[illegible]8)	[illegible]
Clinical Science Degrees					$53,776 (2.22)	$50,740 (2.13)				
Constant	$384,077 (0.70)	0	$1,502,531 (3.98)	0	$1,877,492 (0.84)	0	$1,184,493 (0.95)	0	$73[illegible] (0.93)	0
R^2	0.67	0.65	0.47	-0.24 (5)	0.43	0.41	0.65	0.63	0.54	0.54
Mean Sponsored Research Expenditures	$1,495,788		$1,700,619		$6,385,937		$4,703,889		$4,125,908	
Standard Error of the Regression	$432,412	$423,122	$343,566	$502,663	$2,826,379	$2,809,889	$1,665,312	$1,660,711	$2,220,185	$2,218,186

The basic model is Sponsored Research Expenditures vs. Medical Undergraduates, Basic Science Students, and Interns, Residents, Clinical Fellows.

The first entry is the regression coefficient; immediately below in parentheses is the corresponding t-statistic.

(1) Sponsored research < $2,350,000

(2) Sponsored research > $2,350,000

(3) C - Model with constant

(A) Z-zero intercept model

(S) Negative R^2 Means that a model with only a constant term (equal to mean of independent variable) would give smaller - squared error.

generally not high enough to permit firm conclusions, it appears that clinical science students have the greatest participation in sponsored research; graduate academic students, interns, and residents have some substantial participation; and undergraduate medical students participate very little.[11]

Wing and Blumberg also published a somewhat different set of results than the one already discussed.[19] In this "second" analysis, the basic model was altered to include a dummy variable for state (1) vs. nonstate (0) schools. The results presented were for a "constant" model. These "changed" results are shown in the right hand column of Table 8.

A comparison of per-student costs for Wing and Blumberg's three "all schools" models follows (see Table 9).

The results of the "changed" model, (3), seem to be "more" statistically significant than model (2). (However, it is not clear what the interpretation should be where the model contains both a constant team (which has a negative coefficient) and a constant term (the dummy) for state school expenditures.)

E. Latham Study

Latham used input/output analysis to measure the cost of education at the University of Iowa's medical school. As was mentioned previously, Latham felt that most of the prior studies (notably that by Wing and Blumberg) grossly underestimated the cost of undergraduate M.D. education. Latham felt that the prior studies (a) omitted certain significant "costs", such as value of voluntary faculty services (b) did not adequately measure inter-program resource transfers. Latham believed that input/output analysis would more adequately deal with some of these problems.[13]

TABLE 8: Empirical Results of Wing and Blumberg Study (1964-65 Data) - "Non-sponsored Expenditures" Regressions - Second set of published results

	Class of School				
	Small[a]		Large[b]		
Program	Nonstate (N=15)	State (N=16)	Nonstate (N=29)	State (N=22)	All Schools (N=82)
Medical undergraduates	$ 22 (0.01)	$ -2,580 (-0.89)	$ 828 (0.40)	$ 4,888 (2.16)	$ 2,834 (2.62)
Basic science students	1,674 (0.24)	-4,796 (-0.72)	3,153 (0.56)	6,670 (0.94)	5,609 (1.27)
Intern, residents, and clinical fellows	-395 (-0.11)	13,596 (2.29)	4,878 (2.29)	5,395 (1.67)	4,766 (4.09)
Clinical science degrees			17,211 (1.72)		18,257 (1.85)
Sponsored research	0.305 (0.56)	0.329 (0.46)	0.223 (2.90)	0.099 (0.48)	0.202 (3.15)
State (=1)					1,084,503 (3.99)
Constant	1,617,315 (1.61)	1,602,841 (1.62)	507,349 (0.60)	223,807 (0.20)	-74,618 (-0.18)
R^2	0.09	0.60	0.74	0.60	0.72
Mean Nonsponsored expenditures	2,094,556	3,161,126	4,387,068	5,404,134	4,001,369
Standard error of the regression	774,791	841,819	1,062,292	1,464,878	1,106,396

Note: Basic model is: nonsponsored expenditures vs. undergraduates, basic science students, clinical postdoctoral students, clinical science degree, sponsored research.

The first entry is the regression coefficient; immediately below in parentheses is the corresponding t-statistic.

a. sponsored research less than $2,350,000.
b. sponsored research greater than $2,350,000.

TABLE 9: A Comparison of Pre-Student Costs for Wing and Blumberg's Three "All-Schools" Models

Independent Variables	(1) Constant, But No Dummy	(2) No Constant, No Dummy	(3) Constant and Dummy
Medical Undergrads	$ 3,723 (3.19)	$4,016 (5.41)	$ 2,834 (2.62)
Basic Science Students	$ 6,992 (2.37)	$6,978 (2.38)	$ 3,609 (1.27)
Interns, Residents, etc.	$ 4,143 (3.28)	$4,182 (3.35)	$ 4,766 (4.09)
Clinical Science Degrees	---	---	$ 18,257 (1.85)
Sponsored Research	$ 0.179 (2.87)	$0.181 (2.94)	$ 0.202 (3.15)
Dummy	---	---	$1,084,505 (3.99)
Constant	143,403 (0.33)	---	74,618 (-0.18)
R^2	0.65	0.65	0.72
N	82	82	82

Dependent Variable = nonsponsored expenditures

T -statistics in parentheses

Source: See references 11 and 19.

Table 10 summarizes the average unit costs of various "output activities" specified by Latham, as derived using this methodology. The "M.D. degree" figures ($25,910 for 1967-68, $27,666 for 1968-69) divide to annual figures of $6478 in 1967-68 and $6917 in 1968-69. The table illustrates a pattern of increasing annual costs of education as the medical undergraduate moves through his training.

Latham's estimates for graduate science degrees ($6654 and $7298 for the respective years) are similar to Campbell's estimates. However, Latham's figures for intern and resident training are much higher than are Campbell's.

The right-hand column of Table 10 shows the average costs of 1968-69 outputs at constant (1967-68) factor prices. This removes the effects of inflation in factor prices from the differences in output costs for the two years. When so deflated, it appears that many of these outputs cost less to produce in 1967-68 at University of Iowa than in 1968-69. In fact, the 1968-69 deflated cost was lower than the 1967-68 cost for 9 of the 16 outputs given in the Table.

F. Fein and Weber Study

Fein and Weber attempted an analysis of the factors affecting the cost and financing of medical education. Unfortunately, they included very little empirical material, other than quartile analyses of faculty time allocation, student mix, types of revenues allocations, of funds, and various gross figures (e.g., "2.46 billion dollars was spent on medical school construction completed between 1948-49 and 1967-68"). No regression or similar work was done on medical school cost functions; rather, Fein and Weber discussed why such regression analyses of cost functions would be meaningless. (See II above).

TABLE 10: "Average Costs of Outputs" of Medical School- Latham Study

Output Activity	Cost 1967-1968	1968-1969	1968-1969 Constant Prices[1]
Fresh. M.D. Ed.	$ 4,821	$ 5,807	$ 5,393
Soph. M.D. Ed.	5,563	5,752	5,306
Jr. M.D. Ed.	8,064	9,697	8,790
Sr. M.D. Ed.	9,304	10,064	9,112
M.D. Degree	25,910	27,666	25,728
1st Yr. Resident Ed.	15,610	27,353	25,056
2nd Yr. Resident Ed.	15,307	15,469	14,234
3rd Yr. Resident Ed.	15,101	15,895	14,630
4th Yr. Resident Ed.	15,328	23,748	21,898
5th Yr. Resident Ed.	40,504	24,459	23,442
Intern Ed.	15,391	19,109	17,470
Grad. Sci. Ed.	6,654	7,298	6,773
Post-Doc. Ed.	5,568	3,686	5,458
Post-M.D. Ed.	776	705	653
Nursing Ed.	1,666	2,104	1,950
Pharmacy Ed.	2,002	1,717	1,556

[1] Average costs of 1968-69 outputs assuming that factor prices had not changed from 1967-68 levels.

Source: Latham, Robert J., The Cost of Medical Education: An Empirical Analysis of Production. Doctoral dissertation, Department of Economics, University of Iowa, Iowa City, Iowa, 1971.

The quartile analysis of "total expenditures per full-time student" is shown in Table 11. Among public schools, the quartile with the highest expenditures per student averaged $9700, while the quartile with the lowest expenditures averaged $5000. Among private schools, the range was $9400-$4300. These figures are for "expenditures less sponsored research, per full-time student", and do not represent the cost of educating the M.D. candidate.[12]

G. Comparison of Empirical Results

Table 12 summarizes the empirical results of the Wing and Blumberg, Seven Centers (Campbell) and Latham studies, for M.D. education, resident/intern education, and graduate science degree education. The figures presented for Wing and Blumberg are not the "all schools" figures discussed earlier, but rather the figures derived from an analysis of 22 state schools with large research expenditures (zero-intercept model; see Table 6). These latter figures are used here to make the sample comparable with those of Campbell and Latham, since those two investigators studied only large medical centers, primarily public, which one would expect to have large research expenditures. In general the Wing and Blumberg figures used in this table are less reliable than their "all schools" figures, because of lower T-statistics of the regression coefficients for the former figures.

The "intern/resident" figures presented for Latham are actually his figures for intern education only. Latham did not present one figure for resident education, but rather separate figures for first through fifth year resident education. These ranged (1967-68) from $15,101 (third-year education) to $40,504 (fifth year education, however, the 1968-69 figure for fifth year residents was only $25,459).

TABLE 11: Quartile Analysis of Expenditures Per Student
(Fein and Weber study)

Characteristic used for ranking	Quartile averages Public				Quartile averages Private			
	Highest	Second	Third	Lowest	Highest	Second	Third	Lowest
Total expenditures per full-time student	$ 9,700 (16,900) (6,867)	$ 7,400 (12,400) (5,602)	$ 6,600 (10,000) (5,432)	$ 5,000 (7,900) (3,782)	$ 9,400 (21,100) (4,460)	$ 7,400 (14,700) (4,960)	$ 5,300 (9,800) (3,692)	$ 4,300 (7,300) (3,188)
MCAT science score	8,000 (13,900)	6,700 (10,900)	7,300 (11,600)	6,400 (10,300)	7,600 (17,000)	8,300 (16,800)	4,600 (8,600)	6,100 (10,200)
Ratio of M.D. candidates to full-time students	5,700 (8,800)	7,900 (11,500)	7,200 (11,800)	7,800 (14,300)	5,200 (8,300)	6,300 (12,400)	6,300 (14,500)	8,600 (17,500)

Quartile averages of expenditures per full-time student of United States medical schools, without and with sponsored research funds*, grouped in order of value of selected characteristics, 1955-66.

Source: Fein, Rashi, and Weber, Gerald, Financing Medical Education: An Analysis of Alternatives and Mechanisms. New York, McGraw-Hill, 1971.

*Excluding overhead. Data in parentheses represent expenditures (including sponsored research) per full-time student. Data in brackets represent expenditures per full-time student if total sponsored funds including overhead are subracted from expenditures.

TABLE 12: Comparison of Empirical Results of Several Studies of Annual Per-Student Costs of Medical Education

Study (Year)[6]	M.D. Degree			Graduate Science Degree			Intern/Resident		
	Actual	CPI[1]	MCPI[2]	Actual	CPI[1]	MCPI[2]	Actual	CPI[1]	MCPI[2]
Wing and Blumberg (1964-65)[3]	$5152	$5546	$5901	$6503	$7000	$7449	$5605	$6033	$6420
Seven Centers (1967-68)[4]	$3700	$3700	$3700	$7200	$7200	$7200	$7000	$7000	$7000
Latham[5] (1967-68)	$6478	$6478	$6478	$6654	$6654	$6654	$15,391	$15,391	$15,391 interr only
(1968-69)	$6917	$6638	$6519	$7298	$7004	$6878	$19,109	$18,339	$18,010

[1]Actual Figure deflated by Consumer Price Index, 1967 = 100 (Source: U.S. Dept. of Labor, Bureau of Labor Statistics). C.P.I. picked as representative of "lower bound" of inflationary trend in medical school costs.

[2]Actual Figure deflated by Medical Care Price Index, 1967 = 100 (Source: U.S. Dept. of Labor, Bureau of Labor Statistics). M.C.P.I. picked as representive of "upper bound" of inflationary trend in medical school costs.

[3]Source: Wing, Paul, and Blumberg, Mark S., Operating Expenditures and Sponsored Research at U.S. Medical Schools. Office of Health Planning, University of California, Berkeley, California, 1967. Figures used are for "state school large research expenditures", to make the sample more comparable with the large medical centers used in the other two studies.

[4]Campbell, T. J., Program Cost Allocation in Seven Medical Centers: A Pilot Study. Association of American Medical Colleges, 1969.

[5]Latham, R. J. The Cost of Medical Education: An Empirical Analysis of Production. Doctoral dissertation, Department of Economics, University of Iowa, Iowa City, Iowa, 1971.

[6]"Year" refers to the fiscal year for which data was used in the particular study.

The figures have been deflated by two price indices in order to remove the effects of inflation over time and make the figures more comparable.* The Consumer Price Index was used to remove the effects of price rises in the goods and services which medical schools must purchase. We consider this index to represent the "lower bound" of the inflationary trends in medical college costs. The Medical Care Price Index was used to remove the effects of price rises in medical care - related items which the schools must purchase. We consider this index to represent an "upper bound" on the inflationary trends. The index "M.D. Fees" was rejected as increasing too fast. This index would be closely related to physician costs, and it was felt that salary increase for medical school faculty lag behind increases in physician incomes.

Adjusting the average cost figures (to a base year of 1967) fails to establish a consistent pattern of rising costs over time. Wing and Blumberg's adjusted 1964-65 figures for M.D. education (CPI - $5546, MCPI - $5901) are higher than Campbell's adjusted 1967-68 figures, (CPI, MCPI both $3700), but lower than Latham's adjusted 1967-68 figures (CPI, MCPI - $6478). When adjusted by the Consumer Price Index Wing and Blumberg's "graduate science degree" figure for 1964-65 ($7000) is lower than Campbell's 1967-68 figure ($7200) but higher than Latham's 1967-68 figure ($6654). However, when adjusted by the Medical Care Price

*Price indices are compiled on a calendar-year basis, while the cost of education were made on a fiscal- or academic-year basis. Thus in performing the deflations/expansions in Tables 12, 13, and 14, the price index figures for calendar 1964 were used to adjust the cost estimates for fiscal 1964-65, and so forth.

Index, Wing and Blumberg's 1964-65 figure in this area ($7449) becomes the highest of all three studies. Only in the intern/resident area is a consistent pattern of increasing costs over time established.

In Table 13, the annual per-student cost of education estimates for M.D. degree education, of each of the three studies have been projected over years 1964-65 - 1972-73. Once again, this adjustment was done using the Consumer and Medical Care Price Index, with the former picked as representative of the "lower bound" of inflationary trends in medical school costs, and the latter selected as representative of the "upperbound" of inflationary trends in medical school costs. Thus, Table 13 provides estimates of the annual per-student cost of education for the M.D. degree in each year, 1964-65 - 1972-73, if each study's estimated cost figure were changed only by inflation over time. This therefore assumes (a) the quality of M.D. education does not change over time (b) the production function, and the proportional use of the inputs to M.D. education, do not change over time.

Recalling again that these three studies all dealt with large, primarily state supported medical centers, Table 13 presents three alternative estimates of the per-student cost of M.D. education over time. The estimates based on Wing and Blumberg's and on Latham's studies are substantially higher than the estimates based on Campbell's Seven Center study. For example, for 1972-73, Wing and Blumberg's figure, adjusted by the C.P.I., is $7480, and adjusted by the M.C.P.I., is $8956; while Latham's figure, adjusted by the C.P.I. is $8117, and by M.C.P.I. is $8584. However, Campbell's 1972-73 figure is only $4636 as adjusted by the C.P.I. and $4903 as adjusted by the M.C.P.I.

TABLE 13: Estimates of Annual Per-Student Cost of Education for M.D. Degree, 1964-1972

	Wing and Blumberg[1]		Seven Centers[2]		Latham[3]	
	CPI[4]	MCPI[5]	CPI[4]	MCPI[5]	CPI[4]	MCPI[5]
1972-73	$7480	$8956	$4636	$4903	$8117	$8584
1971-72	7241	8679	4488	4751	7858	8318
1970-71	6943	8152	4303	4462	7534	7812
1969-70	6555	7665	4063	4196	7113	7346
1968-69	6221	7172	3855	3926	6750	6873
1967-68	5970	6759	3700	3700	6478	6478
1966-67	5803	6313	3596	3456	6297	6050
1965-66	5642	6050	3497	3312	6122	5798
1964-65	5546	5901	3437	3230	6018	5655

[1] Based on estimate of annual cost of education made for 1964-65.

[2] Based on estimate of annual cost of education made for 1967-68.

[3] Based on estimate of annual cost of education made for 1967-68.

[4] Deflation/expansion done by Consumer Price Index, 1967 = 100 (Source: U.S. Department of Labor, Bureau of Labor Statistics). C.P.I. picked as representative of "lower Bound" of inflationary trends in medical school costs.

[5] Deflation/expansion done by Medical Care Price Index, 1967 = 100. (Source: U.S. Department of Labor, Bureau of Labor Statistics). M.C.P.I. picked as representative of "upper bound" of inflationary trend in medical school costs.

Sources: See Table 12, Notes 3, 4, 5.

Table 14 presents the results of Table 13 in a different fashion, that is, in terms of the four-year cost of M.D. education instead of the annual per-student cost. Table 14 was prepared by multiplying each of the annual figures in Table 13 times four. Thus, for 1972-73 Wing and Blumberg's "estimates" for the cost of producing an M.D. graduate are $28,964 and $34,716 (as adjusted by C.P.I. and M.C.P.I., respectively). Campbell's figures for the M.D. graduate are $17,952 and $19,004 in 1972-73; while Latham's are $31,432 and $33,272.

One might have several reasonable expectations with respect to the results of the several studies; however, these expectations are not all confirmed. For example, one would expect Latham to have the highest per-student cost of education estimates, since he included more items in his model than did the other studies. Latham does have the highest figures for M.D. education and intern/resident training, but not for graduate science education. Also, one might expect the Seven Centers and Wing and Blumberg studies to present similar cost estimates (when adjusted). This is because these two studies used data collected by essentially the same methodology, and made many of the same inclusions and exclusions in their estimating processes. However, their figures are similar only in the graduate science degree area.

V. SUMMARY

Many problems can prevent the accurate estimation of per-student costs of education in medical schools. This is especially true if one is attempting to estimate an average cost, or construct a "cost curve", using data from many schools; or if one is attempting inter-school comparisons.

TABLE 14: Projections of Estimates of Annual Per-Student Costs of Education for M.D. Degree to Other Years, Converted to Four-Year Costs[1]

	Wing and Blumberg		Seven Centers		Latham	
	CPI	MCPI	CPI	MCPI	CPI	MCPI
1971-72	$28,964	$34,716	$17,952	$19,004	$31,432	$33,272
1970-71	27,772	32,608	17,212	17,848	30,136	31,248
1969-70	26,220	30,660	16,252	16,784	28,452	29,384
1968-69	24,884	28,668	15,420	15,704	27,000	27,492
1967-68	23,880	27,036	14,800	14,800	25,910	25,910
1966-67	23,212	25,252	14,384	13,824	25,188	24,200
1965-66	22,568	24,200	13,988	13,248	24,488	23,192
1964-65	22,184	23,604	13,748	12,920	24,072	22,620

[1]Source: Annual figures from Table 13, multiplied by 4.

Sources: See Table 12, Notes 3,4,5.

Schools do not use uniform accounting systems, nor do they all have the same goals and objectives. Thus a methodology must somehow "standardize" data from different schools. Schools produce multiple outputs, therefore the costs of each school program must be properly measured. This means all inputs (resources used) into each program must be identified and accurate costs assigned to all these resources. Inter-program and inter-departmental resource transfers or "subsidies" must be identified. Expenditures which benefit more than one program-such as a faculty member's salary-must be allocated to all programs benefited according to the amount of the resource each program uses. Obviously any methodology which can do all these things at each school is likely to be very complex and difficult to administer, thus precluding the investigator from studying many schools.

Studies of medical school costs have utilized three general methodologies. These have been labeled "net amount contributed", "costing" and "input/output analysis". No one of these appears to be clearly (empirically) more accurate than the others. However, the input/output method would intuitively appear to be the most accurate.

The "costing" and "input/output analysis" approaches have been subjected to strong criticism by those who say that it is theoretically unsound to distribute medical school costs among individual, unique programs. These critics contend that the "joint costs" between programs, arising from the fact that some programs must be conducted if others are also to be conducted, must be considered. The "joint cost" approach will not lead to estimates of per-student educational costs. However, supporters of "joint costs" feel that the "per-student cost" is not a meaningful statistic.

The empirical results of these studies show no consistent pattern of costs of education over time. One might expect that these cost estimates when adjusted for inflation would show some rising trend due to increasing quality in the medical education process. However, this expectation is not conclusively borne out by the studies, either.

The only data on medical school costs and finances, for all schools, that is continually collected is that collected by AAMC through its annual survey of member institutions. Any investigator not wishing or not permitted to use AAMC data would have to undertake substantial new data collection efforts.

REFERENCES FOR STUDIES

[1]Henricksen, Gerhard C., and Davison, W.C. "Cost of Undergraduate Medical Education in an Endowed School", Journal of the American Medical Association, Vol. 149, p. 99 (May 10, 1952).

[2]Weiskotten, H.G. Medical Education in the United States and Canada, American Medical Association, Chicago, 1940.

[3]National Fund for Medical Education. Medical Education in the United States, New York, 1950.

[4]Federal Security Agency, Public Health Service. Report of the Surgeon General's Committee on Medical School Grants and Finances, Part II, Financial Status and Needs of Medical Schools, Washington, D.C., U.S. Government Printing Office, 1951.

[5]Deitrick, John E., and Berson, Robert C. Medical Schools in the United States at Mid-Century, New York, McGraw-Hill, 1953.

[6]Carroll, Augustus J. A Study of Medical College Costs, Association of American Medical Colleges, Evanston, Illinois, 1958.

[7]Carroll, Augustus J. A Program Cost Finding System for Medical Colleges-Manual of Procedures, Workbook prepared for the Third Institute on Administration, Association of American Medical Colleges, Evanston, Illinois, 1965.

[8]Darley, Ward, Carroll, Augustus J., Powers, Lee and Oppermann, Katherine C. "Sources of Expenditures for Medical Schools," in Wolf, S.G., and Darley, Ward (eds), Medical Education and Practice: Relationships and Responsibilities in a Changing Society. Published as part 2 of Journal of Medical Education, Vol. 40, p. 99 (January 1965).

[9]Carroll, Augustus J., and Darley, Ward. "Medical College Costs", Journal of Medical Education, Vol. 42, p.1 (January 1967).

[10]Campbell, Thomas J. Program Cost Allocation in Seven Medical Centers: A Pilot Study. Association of American Medical Colleges, 1969.

[11]Wing, Paul, and Blumberg, Mark S. Operating Expenditures and Sponsored Research at U.S. Medical Schools, Office of Health Planning, University of California, Berkeley, California, 1969.

[12]Fein, Rashi and Weber, Gerald I. Financing Medical Education: An Analysis of Alternatives and Mechanisms, New York, McGraw-Hill, 1971.

[13]Latham, Robert J. The Cost of Medical Education: An Empirical Analysis of Production, Doctoral Dissertation, Department of Economics, University of Iowa, Iowa City, Iowa, 1971.

[14]National Academy of Sciences, Institute of Medicine. Costs of Education of the Health Professions, Interim Report, Washington, D.C., March 1973.

[15]Anderson, D.G. and Tipner, Anne. "Medical Education in the United States and Canada", Journal of the American Medical Association, Vol. 141, p.43 (Sept. 3, 1944).

[16] Wing, Paul. "Clinical Costs of Medical Education", Inquiry, Vol. IX, No. 4, p. 36 (December 1972).

[17] Carr, W.J., and Feldstein, P.J. "The Relationship of Cost to Hospital Size", Inquiry, Vol. IV, p. 45 (June 1967).

[18] Koehler, John E., and Slighton, Robert L. "Activity Analysis and Cost Analysis in Medical Schools", Journal of Medical Education, Volume 48, p. 531 (June 1973).

[19] Wing, Paul, and Blumberg, Mark S. "Operating Expenditures and Sponsored Research at U.S. Medical Schools: An Empirical Study of Cost Patterns", Journal of Human Resources, VI, pp.75-102 (Winter 1971).